The coefficient of contraction varies from unity, when the areas of the two passages are the same, to 0.83, when the area of the smaller passage is 0.01 of the area of the larger passage. This slightly increases the pressure required, but ordinarily a large margin is available to cover this increase. The loss of pressure due to changes of direction may be expressed by the formula,

in which *r* is a function of the angle through which the stream is deflected. The following values are given by Weisbach for short bends in pipe:

Angular change a =	20°	40°	45°	60°	80°	90°
r =	0.046	0.139	0.188	0.364	0.740	0.984

v= velocity in meters per second; *2g* = gravitational constant =2X9.81.

When the loss of pressure clue to directional changes is desired in inches of water column, the formula is

in which *v* = velocity in feet per second ; 20 = 2X32.2; Aj = weight per cubic foot of gas in motion at *t°.*

The losses, due to directional changes of 180° in the valve and 90° in the flues each side of the

valve, are approximately from two to four times as great as the loss due to restricted valve area. For this reason, changes of diameter of valve of 6 in (150 mm) or so have a comparatively small effect upon operation. These losses vary with the square of the velocity in the valve and the flues. Many furnaces are, undoubtedly, choked by the small area of the valves used, and much operating trouble is doubtless due to lack of consideration of these details.

A valve small enough to choke the furnace is an expensive luxury, as it exacts its toll every minute the furnace is working. Added chimney height or forced draft must be provided to overcome its resistance. There is very little doubt that the erratic working of some furnaces with different weather conditions is